

[4. The invention of claim 3 wherein the capacitive load has a first terminal connected to the first switch and a second terminal connected to a source of a second potential.]

[5. The invention of claim 4 wherein the second switch has a first terminal connected to the first terminal of the load and a second terminal connected to said source of a second potential.]

[6. The invention of claim 5 wherein each of the third switches has a first terminal connected to the first terminal of the load and a second terminal connected to a first terminal of an associated one of the plural capacitive elements.]

[7. The invention of claim 6 wherein the means for selectively activating the first, second and third switches includes a finite state machine.]

[8. The invention of claim 7 wherein the finite state machine is designed to receive a clock signal and an input signal and provide selective activation signals for the first, second and third switches in response thereto.]

[9. The invention of claim 8 wherein a second terminal of each of the plural capacitive elements is connected to said source of a second potential.]

[10. The invention of claim 9 wherein each of the capacitive elements has a capacitance which is at least an order of magnitude greater than the capacitance of the load.]

[11. A method for efficiently charging and discharging a capacitive load from a single voltage source including the steps of:

- providing a first switch for selectively connecting the voltage source to the load;
- providing a second switch for selectively providing a short across the load;
- providing plural capacitive elements;
- providing plural third switches for selectively connecting each of the capacitive elements to the capacitive load; and
- selectively activating the first, second and third switches to gradually charge or discharge the capacitive load.]

[12. A system for charging and discharging a capacitive load comprising:
a first switch system that opens and closes a circuit between the capacitive load and a substantially constant first voltage potential;
a second switch system that opens and closes a circuit between the capacitive load and an energy storage system that always stores energy substantially only in capacitance, said second switch system causing said energy storage system to electrically disconnect from any conducting circuit when said second switch system is open;
a third switch system that opens and closes a circuit between the capacitive load and a substantially constant second voltage potential, the second voltage potential being different from the first voltage potential;
and
a controller communicating with said first, second and third switch systems and causing said switch systems to close and open in a sequential fashion such that the magnitude of the voltage that is delivered to the capacitive load increases and then decreases in a staircase manner;
whereby energy that is delivered to the capacitive load is recovered during decreases in the magnitude of the voltage, and
whereby the recovered energy is always stored substantially only in capacitance and is substantially re-delivered back to the capacitive load during increases in the magnitude of the voltage, thus effectuating energy conservation.]

13.-126. (Previously canceled).

127. An apparatus for driving a capacitive load, comprising:
a voltage source; and
a switch network,
wherein the switch network is operable to electrically connect the
capacitive load and the voltage source to drive the load to a first voltage level,
wherein the switch network is further operable to electrically connect the
capacitive load and a capacitive storage system, and wherein when the

capacitive storage system and the capacitive load are electrically connected by the switch network, a voltage level of the capacitive storage system tends to self stabilize to a second voltage level; and

wherein the switch network is further operable to cause charge to be transferred from the capacitive storage subsystem to the capacitive load and is still further operable to cause charge to be transferred from the capacitive load to the capacitive storage subsystem.

128. An apparatus as claimed in claim 127, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element.

129. An apparatus as claimed in claim 127, wherein the capacitive storage system comprises a plurality of capacitive elements.

130. An apparatus as claimed in claim 127, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive storage system and the capacitive load are electrically floating.

131. An apparatus as claimed in claim 127, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected in parallel.

132. An apparatus as claimed in claim 127, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected such that a first terminal of the first capacitive element is electrically connected to a first terminal of the second capacitive

element and a second terminal of the first capacitive element and a second terminal of the second capacitive element are electrically connected to a common potential.

133. An apparatus as claimed in claim 127, wherein the switch network comprises a plurality of switching elements.

134. An apparatus as claimed in claim 127, wherein the switch network comprises a plurality of MOS transistors.

135. An apparatus as claimed in claim 127, wherein a capacitance of the capacitive storage system is larger than a capacitance of the capacitive load.

136. An apparatus as claimed in claim 127, wherein a capacitance of the capacitive storage system is an order of magnitude larger than a capacitance of the capacitive load.

137. An apparatus as claimed in claim 127, wherein the apparatus is a driver.

138. An apparatus as claimed in claim 127, wherein the switch network is further operable to electrically connect the capacitive load and the voltage source to drive the capacitive load to a third voltage level, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive load settles at a second voltage level between the first and third voltage levels, and wherein during operation of the apparatus, the capacitive load is first driven to the first voltage, then subsequently settles at the second voltage level, and then is subsequently driven to the third voltage level.

139. An apparatus comprising:

a capacitive load;
a voltage source;
a switch network; and

a capacitive storage system,
wherein the switch network is operable to electrically connect the
capacitive load and the voltage source to drive the load to a first voltage level,
wherein the switch network is further operable to electrically connect the
capacitive load and the capacitive storage system, and wherein when the
capacitive storage system and the capacitive load are electrically connected by
the switch network, a voltage level of the capacitive storage system tends to self
stabilize to a second voltage level, and

wherein the switch network is further operable to cause charge to be
transferred from the capacitive storage subsystem to the capacitive load and is
still further operable to cause charge to be transferred from the capacitive load to
the capacitive storage subsystem.

140. An apparatus as claimed in claim 139, wherein the capacitive load
comprises a first capacitive element and the capacitive storage system comprises a
second capacitive element.

141. An apparatus as claimed in claim 139, wherein the capacitive storage
system comprises a plurality of capacitive elements.

142. An apparatus as claimed in claim 139, wherein when the capacitive
storage system and the capacitive load are electrically connected by the switch network,
the capacitive storage system and the capacitive load are electrically floating.

143. An apparatus as claimed in claim 139, wherein the capacitive load
comprises a first capacitive element and the capacitive storage system comprises a
second capacitive element, and wherein when the capacitive storage system and the
capacitive load are electrically connected by the switch network, the first and second
capacitive elements are electrically connected in parallel.

144. An apparatus as claimed in claim 139, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected such that a first terminal of the first capacitive element is electrically connected to a first terminal of the second capacitive element and a second terminal of the first capacitive element and a second terminal of the second capacitive element are electrically connected to a common potential.

145. An apparatus as claimed in claim 139, wherein the switch network comprises a plurality of switching elements.

146. An apparatus as claimed in claim 139, wherein the switch network comprises a plurality of MOS transistors.

147. An apparatus as claimed in claim 139, wherein a capacitance of the capacitive storage system is larger than a capacitance of the capacitive load.

148. An apparatus as claimed in claim 139, wherein a capacitance of the capacitive storage system is an order of magnitude larger than a capacitance of the capacitive load.

149. An apparatus as claimed in claim 139, wherein the switch network is further operable to electrically connect the capacitive load and the voltage source to drive the capacitive load to a third voltage level, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive load settles at a second voltage level between the first and third voltage levels, and wherein during operation of the apparatus, the capacitive load is first driven to the first voltage, then subsequently settles at the second voltage level, and then is subsequently driven to the third voltage level.

150. An apparatus for driving a capacitive load, comprising:

a voltage source; and

a switch network,

wherein the switch network is operable to electrically connect the

capacitive load and the voltage source to drive the load to a first voltage level,

wherein the switch network is further operable to electrically connect the

capacitive load and a capacitive storage system, and wherein when the

capacitive storage system and the capacitive load are electrically connected by

the switch network, the capacitive storage system is electrically isolated from the

voltage source, and

wherein the switch network is further operable to cause charge to be

transferred from the capacitive storage subsystem to the capacitive load and is

still further operable to cause charge to be transferred from the capacitive load to

the capacitive storage subsystem.

151. An apparatus as claimed in claim 150, wherein the capacitive load

comprises a first capacitive element and the capacitive storage system comprises a

second capacitive element.

152. An apparatus as claimed in claim 150, wherein the capacitive storage

system comprises a plurality of capacitive elements.

153. An apparatus as claimed in claim 150, wherein when the capacitive

storage system and the capacitive load are electrically connected by the switch network,

the capacitive storage system and the capacitive load are electrically floating.

154. An apparatus as claimed in claim 150, wherein the capacitive load

comprises a first capacitive element and the capacitive storage system comprises a

second capacitive element, and wherein when the capacitive storage system and the

capacitive load are electrically connected by the switch network, the first and second

capacitive elements are electrically connected in parallel.

155. An apparatus as claimed in claim 150, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected such that a first terminal of the first capacitive element is electrically connected to a first terminal of the second capacitive element and a second terminal of the first capacitive element and a second terminal of the second capacitive element are electrically connected to a common potential.

156. An apparatus as claimed in claim 150, wherein the switch network comprises a plurality of switching elements.

157. An apparatus as claimed in claim 150, wherein the switch network comprises a plurality of MOS transistors.

158. An apparatus as claimed in claim 150, wherein a capacitance of the capacitive storage system is larger than a capacitance of the capacitive load.

159. An apparatus as claimed in claim 150, wherein a capacitance of the capacitive storage system is an order of magnitude larger than a capacitance of the capacitive load.

160. An apparatus as claimed in claim 150, wherein the apparatus is a driver.

161. An apparatus as claimed in claim 150, wherein the switch network is further operable to electrically connect the capacitive load and the voltage source to drive the capacitive load to a third voltage level, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive load settles at a second voltage level between the first and third voltage levels, and wherein during operation of the apparatus, the capacitive load is first driven

to the first voltage, then subsequently settles at the second voltage level, and then is subsequently driven to the third voltage level.

162. An apparatus comprising:

a capacitive load;

a voltage source;

a switch network; and

a capacitive storage system,

wherein the switch network is operable to electrically connect the capacitive load and the voltage source to drive the load to a first voltage level,
wherein the switch network is further operable to electrically connect the capacitive load and the capacitive storage system, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive storage system is electrically isolated from the voltage source, and

wherein the switch network is further operable to cause charge to be transferred from the capacitive storage subsystem to the capacitive load and is still further operable to cause charge to be transferred from the capacitive load to the capacitive storage subsystem.

163. An apparatus as claimed in claim 162, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element.

164. An apparatus as claimed in claim 162, wherein the capacitive storage system comprises a plurality of capacitive elements.

165. An apparatus as claimed in claim 162, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive storage system and the capacitive load are electrically floating.

166. An apparatus as claimed in claim 162, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected in parallel.

167. An apparatus as claimed in claim 162, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected such that a first terminal of the first capacitive element is electrically connected to a first terminal of the second capacitive element and a second terminal of the first capacitive element and a second terminal of the second capacitive element are electrically connected to a common potential.

168. An apparatus as claimed in claim 162, wherein the switch network comprises a plurality of switching elements.

169. An apparatus as claimed in claim 162, wherein the switch network comprises a plurality of MOS transistors.

170. An apparatus as claimed in claim 162, wherein a capacitance of the capacitive storage system is larger than a capacitance of the capacitive load.

171. An apparatus as claimed in claim 162, wherein a capacitance of the capacitive storage system is an order of magnitude larger than a capacitance of the capacitive load.

172. An apparatus as claimed in claim 162, wherein the switch network is further operable to electrically connect the capacitive load and the voltage source to drive the capacitive load to a third voltage level, wherein when the capacitive storage

system and the capacitive load are electrically connected by the switch network, the capacitive load settles at a second voltage level between the first and third voltage levels, and wherein during operation of the apparatus, the capacitive load is first driven to the first voltage, then subsequently settles at the second voltage level, and then is subsequently driven to the third voltage level.

173. An apparatus for driving a capacitive load, comprising:

a voltage source; and

a switch network,

wherein the switch network is operable to electrically connect the capacitive load and the voltage source to drive the load to a first voltage level,

wherein the switch network is further operable to electrically connect the capacitive load and a capacitive storage system, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive storage system and the capacitive load are electrically floating, and

wherein the switch network is further operable to cause charge to be transferred from the capacitive storage subsystem to the capacitive load and is still further operable to cause charge to be transferred from the capacitive load to the capacitive storage subsystem.

174. An apparatus as claimed in claim 173, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element.

175. An apparatus as claimed in claim 173, wherein the capacitive storage system comprises a plurality of capacitive elements.

176. An apparatus as claimed in claim 173, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network,

the capacitive storage system and the capacitive load are electrically disconnected from the voltage source.

177. An apparatus as claimed in claim 173, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected in parallel.

178. An apparatus as claimed in claim 173, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected such that a first terminal of the first capacitive element is electrically connected to a first terminal of the second capacitive element and a second terminal of the first capacitive element and a second terminal of the second capacitive element are electrically connected to a common potential.

179. An apparatus as claimed in claim 173, wherein the switch network comprises a plurality of switching elements.

180. An apparatus as claimed in claim 173, wherein the switch network comprises a plurality of MOS transistors.

181. An apparatus as claimed in claim 173, wherein a capacitance of the capacitive storage system is larger than a capacitance of the capacitive load.

182. An apparatus as claimed in claim 173, wherein a capacitance of the capacitive storage system is an order of magnitude larger than a capacitance of the capacitive load.

183. An apparatus as claimed in claim 173, wherein the apparatus is a driver.

184. An apparatus as claimed in claim 173, wherein the switch network is further operable to electrically connect the capacitive load and the voltage source to drive the capacitive load to a third voltage level, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive load settles at a second voltage level between the first and third voltage levels, and wherein during operation of the apparatus, the capacitive load is first driven to the first voltage, then subsequently settles at the second voltage level, and then is subsequently driven to the third voltage level.

185. An apparatus comprising:

a capacitive load;

a voltage source;

a switch network; and

a capacitive storage system,

wherein the switch network is operable to electrically connect the capacitive load and the voltage source to drive the load to a first voltage level,

wherein the switch network is further operable to electrically connect the capacitive load and the capacitive storage system, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive storage system and the capacitive load are electrically floating, and

wherein the switch network is further operable to cause charge to be transferred from the capacitive storage subsystem to the capacitive load and is still further operable to cause charge to be transferred from the capacitive load to the capacitive storage subsystem.

186. An apparatus as claimed in claim 185, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element.

187. An apparatus as claimed in claim 185, wherein the capacitive storage system comprises a plurality of capacitive elements.

188. An apparatus as claimed in claim 185, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive storage system and the capacitive load are electrically disconnected from the voltage source.

189. An apparatus as claimed in claim 185, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected in parallel.

190. An apparatus as claimed in claim 185, wherein the capacitive load comprises a first capacitive element and the capacitive storage system comprises a second capacitive element, and wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the first and second capacitive elements are electrically connected such that a first terminal of the first capacitive element is electrically connected to a first terminal of the second capacitive element and a second terminal of the first capacitive element and a second terminal of the second capacitive element are electrically connected to a common potential.

191. An apparatus as claimed in claim 185, wherein the switch network comprises a plurality of switching elements.

192. An apparatus as claimed in claim 185, wherein the switch network comprises a plurality of MOS transistors.

193. An apparatus as claimed in claim 185, wherein a capacitance of the capacitive storage system is larger than a capacitance of the capacitive load.

194. An apparatus as claimed in claim 185, wherein a capacitance of the capacitive storage system is an order of magnitude larger than a capacitance of the capacitive load.

195. An apparatus as claimed in claim 185, wherein the switch network is further operable to electrically connect the capacitive load and the voltage source to drive the capacitive load to a third voltage level, wherein when the capacitive storage system and the capacitive load are electrically connected by the switch network, the capacitive load settles at a second voltage level between the first and third voltage levels, and wherein during operation of the apparatus, the capacitive load is first driven to the first voltage, then subsequently settles at the second voltage level, and then is subsequently driven to the third voltage level.